A COMMITMENT TO RESEARCH AND DEVELOPMENT: AN ACTION PLAN

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PREFACE

Last November at the First Ministers' Conference, First Ministers discussed the need for a national action plan to increase Canada's research and development. At the Conference, I proposed that Canada adopt a national R&D target of 2.5 percent of GDP.

This document, "A Commitment to Research and Development: An Action Plan" discusses the reasons why Canadian R&D spending should be increased and suggests a policy planning framework to achieve the target. Proposals are made on how the new R&D spending necessary to reach the target could be funded among the various social partners, including the private sector, universities, federal, provincial and territorial governments.

These proposals detail one way to achieve the target - there are others. The first step is to make the commitment to increased national R&D spending and to make it in a tangible form by agreeing to adopt a national R&D target.

It is hoped that this proposed action plan will encourage debate among all interested Canadians on the need for increasing our national investment in research and development.

HON. DAVID PETERSON
PREMIER OF ONTARIO

Enquiries regarding this Paper should
be directed to:

Ministry of Industry, Trade and Technology
900 Bay Street
Hearst Block, Queen's Park
Toronto, Ontario
M7A 2E1

Technology Policy Branch
(416) 963-1373

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EXECUTIVE SUMMARY

Canada's ability to compete in international markets is increasingly dependent on our ability to use our heads rather than our hands. The emerging industries of tomorrow, with their advanced technology and skilled jobs, will develop in those countries that have the vision to act aggressively today. If Canadians are to be assured of their technological future, there must be a national commitment to developing the technologies which will ensure that future. Key to superior technological development is excellence in the performance of research and development. It is an issue of national concern that Canada is in the minor leagues of world research.

Ontario proposes that in order to increase productivity and international competitiveness, Canadian governments should provide leadership in committing to R&D as a national priority. This commitment can best be expressed in the form of a national R&D target. A national R&D target would set a national policy for R&D effort and provide a framework within which federal, provincial, and territorial government policies and programs in support of R&D investment could be coordinated.

If a national R&D target is to be adopted and Canadian R&D spending is to increase significantly, important questions must be addressed. Why should Canada spend more on R&D? How much more R&D should be performed nationally? Who should perform this R&D? Who should pay for this increased R&D investment? How will all regions of Canada benefit from increased R&D spending?

This action plan illustrates how Canadian R&D spending could be increased. It provides a policy planning framework to achieve a 2.5 percent R&D target (percentage of national R&D investment to gross domestic product) within ten years. Proposals are made on how the new R&D spending necessary to reach the target could be funded among the various social partners, including the private sector, universities, federal, and provincial governments.

If present policies are maintained, the national effort devoted to R&D could drift downwards from its present level of 1.35 percent of GDP. An international comparison of Canada and other major OECD economies shows that Canada is already lagging in R&D spending in general, and industrial R&D spending in particular. Overall, Canada ranks tenth out of twelve in total R&D intensity among the largest industrial economies. Some confusion exists about the reasons behind Canada's relatively low R&D spending. Detailed analysis shows that structural factors of Canadian

industry, such as the economy's specialization in natural resource production, explain only a portion of the gap in R&D spending between Canada and the other advanced economies. The rest of the gap is either unexplained or explained by factors that Canadian governments can change. For example, Canadian government support for industrial R&D is substantially lower than in the United States.

The governments of all advanced industrial economies provide government incentives for R&D. The invisible hand of the market will not, by itself, allocate enough of society's investment to basic and industrial R&D to maximize productivity growth. This is because the benefits of R&D investment are often spread over many firms while the costs and risks are confined to a single firm. There is an important "public goods" aspect to all R&D performance. The role of government working with industry, labour, and educators is to ensure that the economy is performing the appropriate level of R&D to achieve maximum productivity growth and competitiveness.

Achieving the 2.5 percent target within ten years is feasible. To do it, total R&D investment would have to increase in real terms by 9.8 percent per year. This is compatible with reasonable and attainable growth rates in the supply of R&D personnel. Still, it is necessary to take such a long-term commitment one step at a time. The paper suggests that the 2.5 percent target be accepted as a guiding principle for Canadian R&D policy and that firm commitments be made to a five-year interim target. If the interim target was set at 1.8 percent of GDP by 1992, it would fall on the growth path to the ten-year target of 2.5 percent. At the interim date, the policy could be reassessed, and if it was considered appropriate, the original direction would be continued. Otherwise, the objective could be altered.

The interim target would entail total incremental R&D expenditures by governments, industry and universities of about $7.8 billion (1986 dollars) over the next five years. (Incremental R&D expenditures are those necessary to raise Canada's R&D beyond its current percentage of GDP.)

The bulk of this incremental R&D should be performed in industry given Canada's particularly low level of industrial R&D expenditure. The incremental industrial R&D spending necessary to reach the interim target would be about $6.2 billion. Of this, two-thirds would be funded by industry itself; government would fund the remaining third by increasing present incentive levels for industrial R&D investment.

The performance of university R&D will also need to increase. Universities will need to train the highly qualified personnel necessary to perform additional R&D throughout the economy. Canadian governments are concerned about increasing the industrial relevance of R&D performed in universities and shared-cost university-industry programs have been put in place. Following this policy priority, half of the incremental university R&D needed to reach the incremental target should come from industry, while the other half would be supplied by governments.

Who will cover the costs of this incremental R&D? The five-year incremental government funding required to meet the interim target by 1992 is about $2.8 billion; the private sector contribution which would be encouraged is projected at about $4.9 billion.

The primary responsibility for increased government funding of R&D lies with the federal government. For historic and economic reasons, the federal government is responsible for assuring that the overall national R&D investment is sufficient to maximize productivity growth and international competitiveness.

Although the federal government has acknowledged this responsibility, real spending on R&D has been cut in each of the last two years. In the current fiscal year, the federal government has announced new R&D spending as part of the federal InnovAction program; however, this new spending will not offset planned cuts and the net result will be a decline. The limit on R&D tax credits proposed in the federal White Paper on Tax Reform, if adopted, will reduce the value of federal tax incentives for support of industrial R&D by 40 percent, according to representatives of the high technology industries.

Increased provincial government R&D funding will also be required. Provincial governments have become an important source of policy innovation supporting R&D investment in Canada as they have increased their spending on R&D. Several provincial governments have markedly increased their R&D spending in recent years. Therefore, provincial governments might reasonably be expected to act as partners in the funding of incremental R&D needed to achieve the interim target.

Just as national economies require organized and managed programs to enhance R&D effort, so do the various regional economies of Canada. R&D targets are an important instrument for increasing the effectiveness of the regional development programs of government.

Measures can be adopted to ensure that all regions of Canada benefit equally from increased R&D spending. These include the adoption of provincial R&D targets and special funding provisions for the governments of the less industrialized provinces.

A possible extension of the national target is the identification of separate targets on an industry-by-industry basis. Such industry targets would have to be developed in consultation with industry. However, industry targets are not a substitute for a national target. Alone, industry targets commit governments to nothing.

The proposed action plan demonstrates that adoption of a national R&D target is a demanding yet prudent goal for Canadians to set - a goal which will see new wealth created in all parts of Canada through the application of Canadian brains and know-how. Adoption of a target would demonstrate that Canadians are confident of their ability to compete and win on the frontiers of industrial innovation.

To realize this vision, Ontario makes four policy proposals:

- Establish a national R&D target that will demonstrate commitment to increased Canadian R&D investment and provide a framework for cooperative action by governments, industry and universities;

- Set the national R&D target at 2.5 percent of GDP to be achieved by 1997, accompanied by an interim target of 1.8 percent to be achieved by 1992;

- Mandate the Council of Science and Technology Ministers to be responsible for the planning, implementation, and monitoring of the target to:

  - ensure that the incremental R&D expenditures necessary to achieve the target are fairly distributed among the provinces. The council should consider policies such as provincial targets and a lower provincial expenditure burden for the less industrialized provinces;

  - consult with industry on the policy instruments necessary to increase industrial R&D spending and on the possibility of adopting industry-by-industry targets.

- Review and evaluate the design of government incentives to increase industrial R&D investment in order to ensure that taxpayers' money is wisely invested.

I R&D AND CANADA'S ECONOMIC FUTURE

In recent years, technological change has become a subject of paramount concern to policy makers. It is now recognized as the dominant force behind long-term economic growth. The economic importance of technology is not new, but it has only been about twenty years since the practical implications for productivity and employment have begun to be understood and measured.

Countries all over the world are seeking to influence their economic competitiveness through increased support for technological development and as a result R&D expenditures are rising rapidly.

This recognition of the effects of R&D parallels the earlier recognition of the benefits of literacy and mass education. In fact, R&D is the most advanced form of education. Just as the "three R"s were instrumental in the spread of the industrial revolution, R&D is the key component of the new economy - the "fourth R".

In the modern economy, R&D is of prime importance. R&D affects the economy by improving productivity. Productivity advances from R&D can take the form of new or improved products or reductions in cost. Either way, the country's competitiveness improves. Increased investment in R&D is essential to increasing Canada's competitiveness in advanced new industries, and maintaining competitiveness in existing traditional industries.

R&D and Technological Infrastructure

The importance of R&D to the economy goes well beyond the firm or institution that performs it. Science and technology are collaborative and interactive activities. Together they form a "technological infrastructure" which is comparable to the physical infrastructure of transportation and communications' networks. Like physical infrastructure, technological infrastructure is a necessary public resource that is drawn on by all industry sectors.

R&D is the most advanced and important component of the technological infrastructure. The direct and indirect connections of R&D to productivity are well established. Many studies have found a statistically strong relationship.[1] The effects of R&D on productivity are often expressed in the form of a rate of return. If the rate of return to extra R&D is above the rate of return to other potential investments, it makes sense to invest more in R&D. A recent study found that the rate of return to

increased industrial R&D in Canada is around 60 percent, which is well above the rate of return to most other investments.[2]

R&D and Competitiveness

Productivity improvements are, in turn, directly linked to international competitiveness. Of course, competitive differences are often short lived. Changes in prices, wages, and exchange rates tend to restore the competitive balance after it has been upset by an improvement in one country's productivity. However, competitive advantages are continually renewed by new product or cost improvements. This is why firms need to do R&D continuously as a long-term strategy for survival.

Although fleeting, competitive shifts are the market's signal that the comparative advantage of a nation has changed. If Canada has a comparative advantage in an industry, it will tend to export the products of that industry. In those industries where Canada has a comparative disadvantage, it imports. Thus, comparative advantage determines a country's industrial structure.

It used to be thought that comparative advantages were determined entirely by natural resource endowments. It is clear now, however, that technology is a primary determining factor in a country's comparative advantage. Canada has a strong telecommunications industry but not a strong fine chemicals industry because domestic technology has been developed for one but not the other.

In fact, technology is important in traditional industries as well. Canada is facing increased competition in resource industries from developing countries. This change was not caused by a sudden increase in the resource endowment of developing countries - the resources were always there - the change was caused by developing countries applying technology more comparable to that in advanced countries.

In the very long term, the value of resources is itself determined by technology. For example, uranium was worth little before the development of nuclear technology, while rare metals like molybdenum and titanium were mere scientific curiosities until the development of techniques for using them as steel hardeners. Even petroleum was worth little before the development of the internal combustion engine. New technology can also reduce the

value of resources. For instance, current developments in structural materials, high temperature ceramics, and fibre optics have been reducing the value of steel and copper.

In order to create industrial strengths in new industries, and protect existing strengths, Canada will have to develop indigenous technology. If this is not done, comparative advantage will be retained in only those industries where possession of resources is paramount and Canada retains a natural bounty.

R&D and Technology Diffusion

It is inevitable that a small country like Canada will produce only a fraction of the world's technology. It is crucial that foreign sources of technology be adopted and diffused to maximum advantage.

This fact does not diminish the importance of domestic R&D. It has been shown that R&D and adopted technology are often complements rather than substitutes.[3] It is often necessary to do R&D in order to benefit from technology that is produced elsewhere. In fact, R&D's role in helping firms absorb outside technology is one of its primary benefits.

International R&D Comparisons

Canada performs considerably less R&D relative to its gross domestic product (GDP) than most other advanced industrial countries. It is also true that some newly industrialized countries such as Korea have higher R&D intensities (percentage of R&D to GDP) than Canada.[4]

While the R&D intensities of most advanced countries have been rising in a long-term trend, Canada's R&D intensity has not risen significantly since the 1960s. In fact, in 1986 it was 1.35 percent of GDP, which was not much higher than the 1971 figure of 1.32 percent.[5] Canada's R&D intensity declined considerably through the middle 1970s, reaching a low of 1.03 percent in 1976. From 1976 to 1982, the figure climbed to 1.36 percent but since then no progress has been made.[6]

Table 1 shows R&D as a percentage of GDP by sector of performance for the 12 largest OECD countries. Overall, Canada ranks tenth out of twelve in total R&D intensity among the largest industrial economies. Canada is tenth in the industry sector and eighth in the university and government sectors.

TABLE 1

R&D as a Percentage of GDP, for the Largest 12 OECD Economies
(1986 or latest year)

	Total R&D	Industry	University	Government
United States	2.89	2.07	0.39	0.34
Japan	2.81	1.88	0.57	0.28
Sweden	2.79	1.97	0.69	0.12
Germany	2.66	1.92	0.40	0.33
France	2.38	1.40	0.37	0.60
United Kingdom	2.33	1.47	0.32	0.46
Switzerland	2.28	1.69	0.40	0.13
Netherlands	2.06	1.16	0.47	0.38
Italy	1.47	0.85	0.28	0.35
Canada	**1.35**	**0.68**	**0.32**	**0.32**
Australia	1.14	0.39	0.30	0.44
Spain	0.48	0.28	0.08	0.12

Sources: OECD, "Selected Science and Technology Indicators, Recent Results"; and special Statistics Canada tabulations.

TABLE 2

An International Comparison of Industrial R&D
(1986 or latest year available)

	Industrial R&D as a Percent of all R&D	Other R&D as a Percent of all R&D
Switzerland	74.3	25.7
Germany	72.2	27.8
U.S.	71.9	28.1
Sweden	70.7	29.3
Japan	66.8	33.2
U.K.	63.1	36.9
France	58.7	41.3
Spain	57.5	42.5
Italy	56.9	43.1
Netherlands	56.5	43.5
Canada	**50.8**	**49.2**
Australia	33.9	64.1

Sources: OECD, "Selected Science and Technology Indicators, Recent Results"; and special Statistics Canada tabulations.

As Table 2 shows, the most striking difference between Canada and other advanced countries is the relatively low level of Canadian industrial R&D. Although it remains low, the industry share has risen in recent years. In 1977, 37 percent of Canada's R&D was performed in industry.[7] In 1986, this share was 51 percent. An industry share of 60 to 65 percent would put Canada in the middle range compared to other advanced countries.

II THE REASONS FOR CANADA'S LOW R&D PERFORMANCE

Various explanations have been put forward to account for Canada's low industrial R&D performance. These include structural differences such as the relatively small size of Canadian firms, Canada's more resource-oriented industrial structure, access to foreign markets, the high degree of foreign control of Canadian industry, and the relatively low level of government support.

Firm Size

Some argue that the small size of Canadian firms is a significant factor accounting for Canada's low industrial R&D intensity. This contention is not supported by the evidence. It is true that most industrial R&D is done by a relatively small number of large firms, but industry sales are also dominated by the same large firms. Among R&D performers, the ratio of R&D to sales actually declines slightly with size. (see Appendix A)

Furthermore, there are many countries smaller than Canada that also have relatively small firms in comparison to the industrial giants, but have much higher R&D intensities than Canada.

Industrial Structure

The difference in industrial structure between Canada and other countries does play some role. Canada has a relatively large share of its industry made up of resource-related activities that have lower R&D intensities than other industries.

However, a comparison between Canada's industrial structure and that of other countries illustrates that this factor is less important than some would argue. For example, industry differences account for about a quarter of the difference between the U.S. and Canada in R&D intensity. A detailed analysis shows that if the U.S. had a similar industrial structure to that of Canada, their R&D intensity would be about 2.5 percent of GDP instead of 2.9 percent. (see Appendix B)

Access to Foreign Markets

Another factor that affects the incentive to perform R&D is access to foreign markets. It is unclear how much this affects Canada's low R&D performance. Canada already has access to most of the U.S. market in the R&D intensive

industries. As well, Canada has at least as much access as the U.S. to the rest of the world's markets. In addition, other countries with small domestic markets, and no more access to international markets than Canada, manage R&D levels that are much more comparable to the industrial giants.

Foreign Control of Industry

A substantial factor in Canada's low industrial R&D intensity is foreign control of industry. Foreign-controlled firms are far less R&D intensive, on average, than Canadian-controlled firms. In 1984, Canadian-controlled R&D performers had an average R&D intensity of 1.5 percent of sales, as compared to 0.9 percent for their foreign-controlled counterparts[1].

That comparison actually understates the difference because foreign control is higher in the more technology-intensive industries. As Table 3 shows, when Canadian and foreign-controlled firms are compared within industries, the difference is much larger. Canadian-controlled firms in technology intensive industries are generally far more R&D intensive than their foreign-controlled counterparts in the same industry.

TABLE 3

R&D To Sales Ratios
for the Most R&D Intensive
Industries in Canada, for 1979

	U.S.	Canada	Canadian Controlled*	Foreign Controlled*
Business Machines	11.8	1.5	8.0	1.3
Other Machinery	2.1	0.9	1.1	0.7
Aircraft & Parts	11.4	10.2	19.0	5.2
Communications Equip	8.4	9.1	9.7	5.5
Other Electrical	5.1	1.4	1.0	1.1
Drugs & Medicines	6.1	4.7	7.5	3.5
Other Chemicals	2.7	1.0	2.6	0.7
Scientific Equipment	5.7	1.7	17.7	0.7

Sources: Economic Council of Canada, The Bottom Line, 1979; Statistics Canada, 88-202, 1983; and National Science Foundation, 82-317, 1980.

* Current R&D Expenditures only.

The table also shows the R&D intensity for the entire industry and its counterpart U.S. industry. Although Canadian industries are generally less R&D intensive than U.S. industries, the Canadian-controlled portion of most industries has an R&D intensity comparable to their U.S. counterparts. In several cases the Canadian-controlled portion of the industry actually has a higher R&D intensity than the corresponding U.S. industry.

Government Support of Industrial R&D

A final important factor in Canada's low industrial R&D performance is government support. The U.S. directly funds 34 percent of industrial R&D in that country compared to 12 percent government funding in Canada[2]. Canada's more generous tax credits alleviate less than a third of this 22 percent difference, leaving a large gap between Canadian and U.S. government support. (see Appendix C)

III GOVERNMENT R&D POLICY IN CANADA

Certain forms of research and development are "public goods". This means that these activities are economically worthwhile but are not carried out by industry because firms have no way of making a profit through them. Basic scientific research generally falls into this category; for example, much of the R&D that is done by universities. There is widespread agreement that this type of R&D needs to be government funded, although the optimal level of such expenditures is difficult to judge.

A more contentious question is whether or not the government should concern itself with the kind of R&D that industry performs. Although firms can and do make profits from R&D, it is not sufficiently profitable for them to perform the nationally optimal amount of R&D. R&D has a greater value for the economy as a whole than it does for individual firms, so it makes sense for government to create additional incentives.

The benefits of R&D investment are often spread over many firms, while the costs are confined to a single firm. This is an important difference between R&D and most other forms of industrial investment. No system of intellectual property or industrial secrecy can keep the benefits of R&D entirely within the performing firm. Some of the benefits of industrial R&D necessarily "spillover" to other firms.

The existence of spillover benefits means that even if the economy-wide benefits outweigh the costs, an R&D investment may not be undertaken because no single firm receives a large enough share of the benefits to make a profit. So even when firms act efficiently, in accordance with their individual interests, R&D will be under funded.

The exceptional level of risk involved in R&D is another reason that it will likely be under funded by industry in the absence of government support. This high level of risk represents a strong disincentive to invest in R&D, for small firms especially.

Until recently, industrial policy concentrated on providing the economy with infrastructure such as roads, hydro and intercity communications networks. In Canada governments have been relatively effective in providing this physical infrastructure. It has become increasingly clear, however, that technological infrastructure is also crucial to industrial success. Technological infrastructure is the network of people, firms, and other institutions, that interact to create and absorb new technology.

Government support of R&D is similar to government funding of education. R&D, like education, is part of the technological infrastructure. In Canada, providing infrastructure has always been the function of the government. Public support for R&D is a consistent extension of Canada's traditional industrial policy in response to the changing requirements of the modern economy.

Provincial Governments' R&D Policy

Provincial governments have become an important source of policy innovation supporting R&D investment in Canada as they have increased their investments in R&D. This trend towards stronger provincial support for R&D investment demonstrates the commitment of provincial governments to increasing R&D investment.

Several provincial governments have markedly increased their R&D spending in recent years; the governments of British Columbia, Alberta, and Saskatchewan increased their R&D expenditures significantly in 1986-87. The Quebec government announced a series of new initiatives supporting R&D spending in universities and industry in its April 1987 Budget.

The latest figures for R&D expenditure by the government of Ontario show a significant new commitment to R&D spending in recent years. In 1987-88, the Ontario government plans to increase its real spending on R&D by about 15 percent (preliminary estimate) over the previous year.

With the increased provincial commitment to R&D spending has come an innovative surge of new policy instruments. For example, the Quebec government's Societe de developement industriel (SDI) manages the Programme d'aide à la recherche et à l'innovation (PARIQ).

This program encourages industrial R&D by offering royalty loans to small businesses during their start-up and early growth phases. The government of Quebec also announced a series of new provincial tax incentives aimed at increasing industrial R&D spending and promoting university-industry cooperation.

The Alberta government has identified areas of technological importance to the province and implemented major programs in their support. The Alberta Oil Sands Technology and Research Authority and the Alberta Heritage Foundation for Medical Research (AHFMR) fund R&D important to the economic development of the province.

The Ontario government has funded a $1 billion Technology Fund with three components addressing various aspects of the Province's R&D requirements including seven Centres of Excellence, the Technology Fund (Industrial Component), and the University Research Incentive Fund.

The Federal Government's R&D Policy

There is no question about the federal government's stated commitment to increasing R&D. During the 1984 federal election campaign, a commitment was made to double Canadian R&D from 1.3 percent of GNP to 2.5 percent within the first four years of coming to power.[1]

In March 1987, Prime Minister Mulroney gave a major speech on research and development at the University of Waterloo. He declared that his government had put science and technology at the top of the national agenda.[2] In 1987, the National Advisory Board on Science and Technology was founded to help develop national science and technology policies related to industrial technology. A new federal program, called InnovAction, was announced in March. The objective of InnovAction is to focus federal activities in several areas important to R&D policy.

However, in the face of the overriding federal government priority of reducing the budgetary deficit, the federal government has given science and technology a low priority in what really counts, its spending decisions. Table 4 shows that the federal government cut its real funding of R&D by 2.5 percent in 1985/86; a small 0.3 percent cut was experienced in 1986/87; and in the present year, plans are to cut a further 1.3 percent, after including new R&D spending announced as part of the federal InnovAction program.

The federal government would still need to spend about $110 million more on R&D in 1987/88 to make up for the previous cuts in R&D spending. A further $220 million would have to be spent in 1987/88 for federal R&D spending to be the same proportion of GDP that it was in 1984/85.

As the government has been reducing its aggregate R&D spending, it has also carried out a redistribution of R&D spending within the government. R&D spending by several departments and agencies with traditional, major science responsibilities is being reduced in 1987/88. The federal government plans to reduce the R&D budgets of many departments with important economic and regional development responsibilities: the Departments of Fisheries and Oceans, Communications, Agriculture, and the National Research Council. The department receiving the largest R&D funding increase is the Department of National Defence which will see its R&D spending jump by over 7 percent in real terms.

If the federal government continues to reduce its R&D commitment to traditional areas of national and regional strength in Canada, federal research expenditures will become less effective in supporting private sector productivity growth and international competitiveness.

TABLE 4

Federal Government R&D Expenditure Trends

	Billions $ (Current)	Billions $ (Constant 1981)	Nominal Annual % Change	Real Annual % Change
80/81	1.388	1.537	14.05	3.06
81/82	1.679	1.679	20.97	9.23
82/83	1.939	1.781	15.49	6.05
83/84	2.222	1.944	14.60	9.18
84/85	2.505	2.116	12.74	8.83
85/86	2.526	2.064	0.84	-2.46
86/87	2.589	2.058	2.49	-0.28
87/88(A)	2.580	2.000	-0.35	-2.82
87/88(B)	2.620	2.031	1.20	-1.31

(A) This row represents the federal government's R&D expenditure plans for 1987/88 drawn from the Main Estimates tabled in the House of Commons on March 2, 1987.

(B) This row includes the federal government's R&D expenditure plans for 1987/88 drawn from the Main Estimates, plus a MITT estimate of new federal R&D spending implied under the various elements of the InnovAction Program announced to date.

Note: Figures for 1980/81-1985/86 are actual federal expenditures; figures for 1986/87 are forecast federal expenditures. Federal tax expenditures resulting from the federal R&D tax incentives are not included in this table.

Sources: Statistics Canada, Federal Scientific Activities, 1986/87, 88-204, 1987; Statistics Canada, Federal Science Expenditures and Personnel, 1987/88, 1987; MOSST, InnovAction News Releases.

IV PERFORMANCE TARGETS FOR R&D

Targets for R&D expenditure are used in many countries to give impetus to national policies for increasing R&D. Usually, R&D spending targets are expressed as a percentage of GDP.

Setting an R&D target would, in effect, establish a national policy for R&D effort. The alternative is an ad-hoc or piecemeal approach in which a separate policy decision is made for each R&D investment. In other policy areas, such as foreign development assistance, expenditure targets are the accepted means of defining commitments.

If there are no clear overall objectives, policy tends to get bogged down in detail. Targets allow policy makers to set broad directions in a clear and unambiguous fashion, while leaving the detailed decisions to the appropriate institutions. Most importantly, firm commitments to aggregate targets give R&D policy a focus.

Targets provide a cohesiveness of purpose that is crucial even within levels of governments, and is especially critical, in Canada, if federal and provincial policies are to be coordinated.

Industry must also see a demonstration of government commitment before it can justify getting on side. The better the infrastructure and incentives that the public sector provides, the greater the opportunities and incentives for individual firms to increase their own technology development. If firms lack confidence in governments' commitment to R&D, they will not be able to justify as large a commitment of their own.

Industry Targets

A possible extension of the national target strategy is the identification of separate targets for each industry sector. Such sectoral targets, aggregating to the national industrial R&D target, must be worked out in consultation with industry. However, industry sector targets are not, by themselves, a substitute for a national target. The main advantage of national targets is that they provide a clear indication of government commitment and provide a framework for joint action by all parties to the economic growth process.

Experience with R&D Targets

Many countries use R&D targets. The Japanese have been especially successful in using targets to shift to a more R&D intensive industrial structure over the last two decades. They have continually met and surpassed the national targets they have set for themselves. The latest figures show Japan's total R&D expenditures to be very close to 3 percent of GDP, which was the previous target.[1] Japan has now set a new target of 3.5 percent.[2]

Korea's R&D story is probably one of the most astonishing: their R&D expenditures rose from a 1.09 percent of GDP in 1981 to 2.0 percent in 1986, in accordance with a target set in 1981.[3] Korea's current plan calls for the achievement 3.0 percent by 1991.[4]

France, on the other hand, was only partially successful in its recent experience with a national R&D target. In 1982, the French established a target of 2.5 percent to be achieved by 1985; the actual figures went from 2.01 percent in 1981 to 2.31 percent in 1985, so the French achieved about 60 percent of their hoped for increase.[5]

Canada's past experience with an R&D target was also partially successful. In 1978, a target of 1.5 percent of GNP was set by the federal government to be achieved by 1985 (originally 1983).[6] By 1985, the figure was up to 1.3 percent from the 1978 level of 1.0 percent.[7] Thus, about 60 percent of the desired increase was achieved.

The Appropriate Level of R&D

Ideally, the optimal level of spending on R&D occurs when all R&D investments are made that have a rate of return higher than alternative investments. This is a general rule that is true for all forms of investment. The difficulty with regard to R&D is that it is very hard to estimate, even after the fact, the rate of return to particular R&D investments. Only measures of the returns to broad categories of R&D are presently possible. These measures do indicate that considerably more industrial R&D is required.

One approach is to increase R&D at the rate allowed by personnel supply constraints, while continuing to monitor the benefits in terms of incomes, jobs and exports. When the benefits to additional R&D no longer exceed the cost, the R&D intensity would be leveled.

International comparisons form an alternative criteria for choosing the level of R&D. Canada is clearly well below other advanced countries in its performance of R&D. Industrial R&D expenditures have now reached 51 percent of total R&D as shown in Table 2. It would take a level of about 60 to 65 percent to make Canada comparable to other advanced countries in this respect.

In itself, Canada's low level of spending relative to other countries does not prove that Canada's R&D outlays are too low; other countries could be investing too much in R&D. However, it seems much more likely that the other advanced countries are on the right track, and Canada is not, than that the reverse is true.

The international competitive aspect is also important. Although there remains uncertainty with regard to the optimal level of R&D, the consequences of being wrong on the low side could be far more severe than the consequences of being wrong in the other direction. Too much investment in R&D would mean that there was some misallocation in Canada's investment portfolio, but too little investment could mean that whole industries would be lost or stillborn.

R&D Personnel

One of the main criticisms that has been made of targets is that the required growth rates would be higher than the potential rate of increase in available R&D personnel. Examination of the evidence shows that this is not the case. Between 1977 and 1982, real industrial R&D expenditures rose by an average of 13.3 percent per year (see Table 5). This growth rate was achieved without significant shortages of R&D personnel occurring.

Clearly, the necessary growth rates are not out of line with the potential for increase indicated by past experience. If such rates of growth can be achieved for five years consecutively, there is little reason to believe they could not be achieved for ten years. Furthermore, other countries are managing even higher R&D growth rates.

VII ACHIEVING THE TARGET

At the November 1986 First Ministers' Conference, Ontario proposed that Canadians consider taking up the challenge of a 2.5 percent target to be reached within 10 years in a collaborative federal-provincial-territorial initiative.

Many Canadian leaders have also advocated the use of national and provincial R&D targets. As early as the 1970's, the Senate science committee proposed a target of 2.5 percent. The Council of Maritime Premiers recommended that "provincial governments each announce targets for total investment in research and development as a percent of gross provincial product."[1] More recently, provincial Premiers have jointly called for a doubling of R&D expenditures.

The 2.5 target, if achieved quickly, would place Canada in the top cluster of OECD countries in terms of R&D expenditure. It would take considerable time to reach such a target and the numbers for other countries have been rising rapidly of late. If the target of 2.5 percent is reached within ten years, it is likely that Canada's R&D intensity would be about average for an advanced country.

The latest estimate for 1986 puts R&D expenditures at about 1.35 percent of GDP[2]. Preliminary figures indicate that for 1987 the ratio will be down slightly to 1.32[3]. The proposed 2.5 percent target is compatible with reasonably attainable growth rates. In order for the ratio to rise to 2.5 percent within ten years, R&D would have to increase in real terms by 9.8 percent per year.

This is illustrated in Figure 1. The historical figures from 1977 to 1987 are from Statistics Canada; the last ten years represent a projection of what would be necessary to achieve the goal of 2.5 percent within ten years.

The targeted R&D is shown as a percentage of GDP in Figure 1A, and in millions of constant 1986 dollars in Figure 1B.

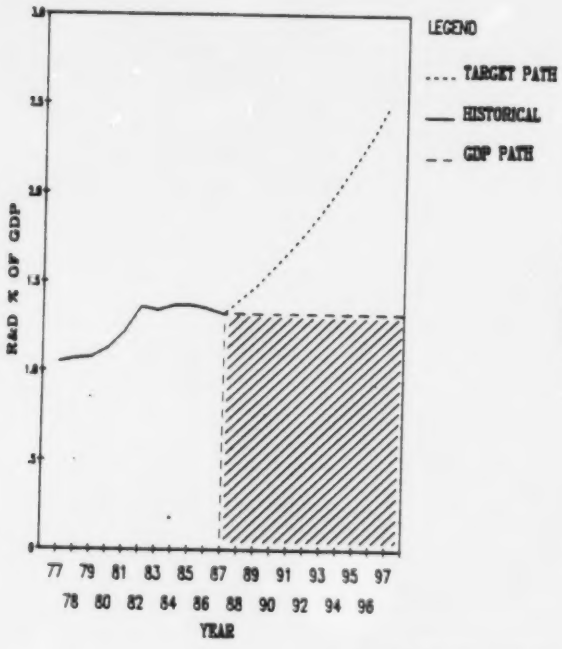
The solid lines represent the actual historical figures for the last ten years. The dotted line from 1987 to 1997 is the target path. The broken line below the target path represents what would happen if R&D merely kept pace with real GDP growth.

FIGURE 1

TOTAL R&D AS PERCENTAGE OF GDP

Constant 1986 Dollars

Figure 1 A

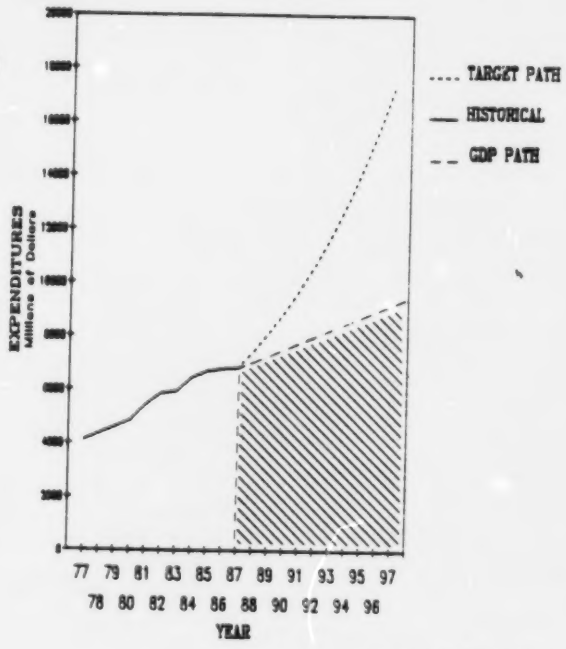


Source: Statistics Canada(1977-87)

TOTAL R&D EXPENDITURES

Constant 1986 Dollars

Figure 1 B


.... TARGET PATH
— HISTORICAL
-- GDP PATH
EXPENDITURES
Millions of Dollars
77 79 81 83 85 87 89 91 93 95 97
78 80 82 84 86 88 90 92 94 96
YEAR

Source: Statistics Canada(1977-87)

An Interim Target

Ontario proposes that the 2.5 percent target be accepted as a guiding principle for Canadian R&D policy and that firm commitments be made for a five-year interim target.

If the interim target is set at 1.8 percent of GDP to be achieved by 1992, it will fall on the constant growth path shown in Figure 1. This interim target provides a realistic time frame for government commitments, while maintaining the integrity of the 2.5 percent goal. At the interim date, the policy could be reevaluated in light of new conditions. If the 2.5 percent target no longer appeared appropriate from the improved vantage of 1992, it could be adjusted.

Financial Implications by Major R&D Sector

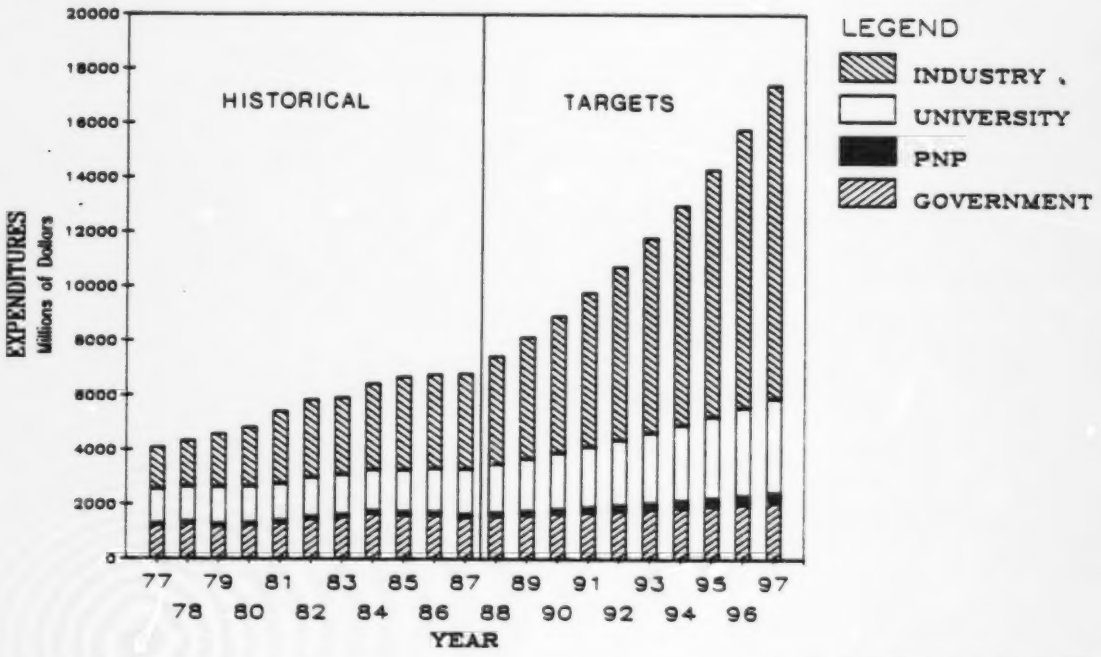
In Figures 2 and 3, R&D expenditures are shown by performing and funding sector respectively. Figure 2 shows that the lion's share of growth in R&D is targeted for the industrial sector. Significant, but less dramatic growth is recommended for the university sector.

FIGURE 2

TOTAL R&D BY PERFORMING SECTOR

Constant 1986 Dollars

Figure 2



Source: Statistics Canada (1977-87)

Note: PNP is the private non-profit sector.

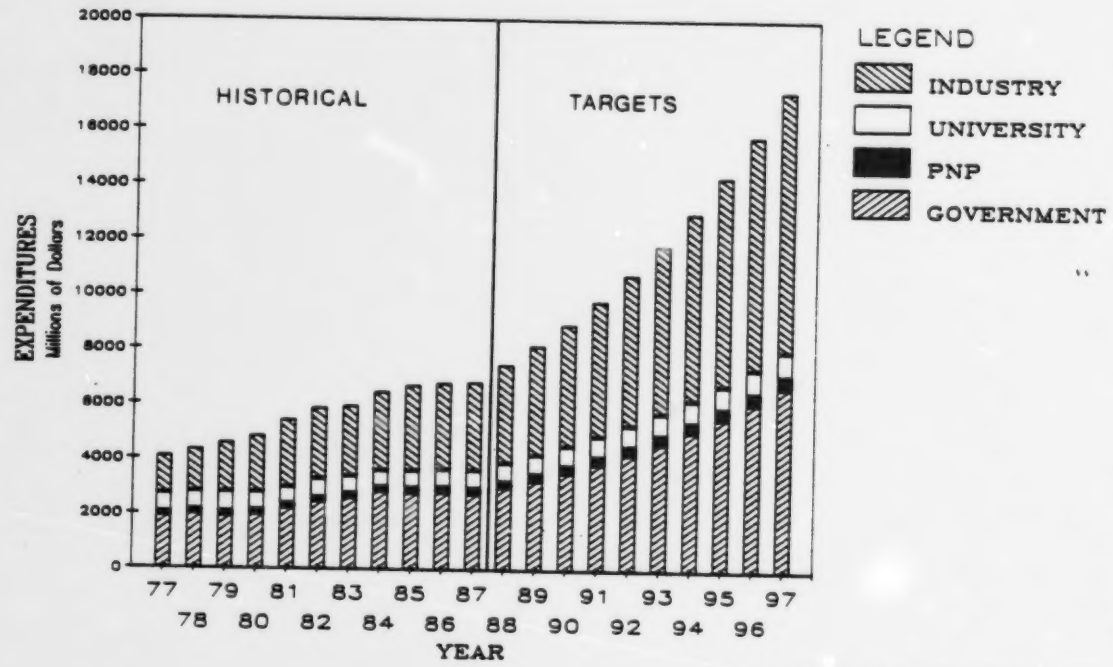
These targets would result in governments' share of total national R&D performance falling gradually from 23 percent in 1987 to 12 percent by 1997. Industry's share would rise from 51 percent in 1987 to 66 percent by 1997.

Figure 3 shows that the industry share of incremental funding is also much larger than the government share, though the government share of funding would still be substantial. Increased government funding is necessary to stimulate industry to increase its spending by this amount.

FIGURE 3

TOTAL R&D BY FUNDING SECTOR
Constant 1986 Dollars

Figure 3



Source: Statistics Canada (1977-87)

Although government R&D funding would rise, the government share of funding would fall from 40 percent to 38 percent of the total by 1997, while the industry share would rise from 47 percent to 54 percent.

The incremental expenditures for the entire five years of the interim period total $7.8 billion in 1986 dollars. About $2.8 billion of this would have to be funded by government, while the remaining funds could be come from the private sector if governments spent their share in a manner which would provide the necessary leverage of private funds.

Industrial R&D

Industrial expenditures have been the highest R&D priority of Canadian governments for some time. This is because it is in the industrial area that we have been particularly lacking relative to our competitors. Industrial R&D expenditures increased substantially between 1977 and 1982. In that period, industrial R&D expenditures increased over 85 percent in constant dollar terms and the ratio of industrial R&D to GDP increased substantially. Since then, as shown by Table 5, the rate of increase has tailed off considerably and the ratio of industrial R&D to GDP has stagnated.

TABLE 5

Canadian Industrial R&D Expenditures

Year	Constant 1986 dollars	% of GDP
1977	1,542	0.39
1979	1,952	0.46
1981	2,672	0.60
1982	2,873	0.66
1983	2,843	0.64
1984	3,174	0.67
1985	3,423	0.70
1986	3,457	0.68
1987	3,513	0.68

Source: Statistics Canada, 88-202, 1984 and special Statistics Canada tabulation.

Industry tends to underinvest in R&D compared to the needs of the economy. This is because of spillover benefits and the exceptional risk involved in R&D. The risk keeps R&D investments with high private rates of return from being made. A recent Science Council study found an average private rate of return on new R&D investment of about 38 percent for nine industries. The spillover benefits do not show in the private rate of return but are included in the "social rate of return". The Science Council study also found a social rate of return which averaged 58 percent.[4]

Figure 2 shows industrial R&D performance rising to about 58 percent of total Canadian R&D expenditures by the interim target date of 1992 and to 66 percent of all R&D by 1997. Currently, industrial R&D is about 0.68 percent of GDP. The target path has this figure rising to 1.05 percent

by 1992 and 1.65 percent by 1997. To reach these targets a growth rate for real industrial R&D of about 12.6 percent per year would be needed. It should be noted that the required growth rate is actually less than the 13.3 percent average that was achieved in the 1977 to 1982 period.

The incremental industrial R&D expenditures required to reach the interim target would be approximately $2.29 billion per year by 1992 in constant 1986 dollars. The incremental expenditures for the entire five-year interim period would be about $6.2 billion or about 80 percent of the $7.8 billion total of incremental expenditures.

How much of this would government have to fund through support programs and how much could we expect industry to invest? The best estimates indicate that for every dollar of R&D tax expenditures, firms increase R&D by about 1 to 1.7 dollars[5]. Similarly, estimates of the effect of R&D grants indicate that an extra dollar of R&D grants generates about 1.5 to 2 dollars of R&D spending.[6]

These estimates indicate that the government would have to provide at least half of the money for incremental R&D in the private sector. However, there will also be some increase in industrial R&D intensities for reasons other than new government support. First, there is a significant long-term trend toward increased industrial R&D intensities which indicates an upward trend in the private incentives for R&D expenditures.[7] Second, the federal government is increasing the protection for intellectual property in Canada. In addition, there are a number of other initiatives that government can take to improve incentives for R&D indirectly that do not necessitate government spending (see Section VII).

Because of these factors, it would be reasonable to expect that the required increase in industrial R&D could be accomplished if governments were prepared to provide one-third of the money. This would mean that the required incremental government funding for industrial R&D would be about $2.1 billion 1986 dollars for the five years to 1992.

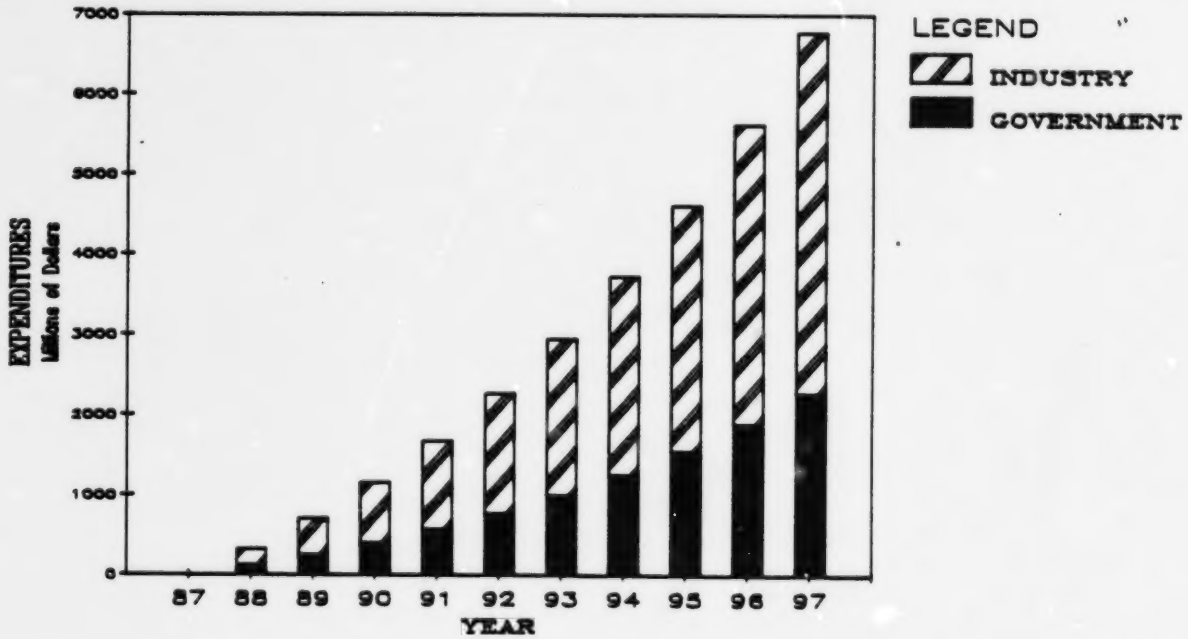
Some of this extra money (about $500 million) could be provided automatically by tax incentives now in place if industry provides its share (see Appendix C). It should be noted, however, that the federal government's proposal to limit R&D tax credit claims as part of tax reform would reduce the tax incentives for R&D considerably. If this is implemented, higher R&D levels will be more difficult to achieve (see section VII).

Incremental industrial spending would be twice governments' share or about $4.1 billion 1986 dollars over the first five years. Half of this would be directly levered by new government support and the other half would result from the independent trend toward higher private R&D and nonbudgetary measures by government.

FIGURE 4

INCREMENTAL INDUSTRIAL R&D
BY FUNDING SECTOR
Constant 1986 Dollars

Figure 4



University Research

Fundamental research is usually conducted in institutes of higher education. For the sake of brevity the term "university R&D" is used in this paper to refer to all higher education R&D.

As yet, there are not any adequate statistical measures of the rate of return to university R&D comparable to those for industrial R&D. The analysis of the preferred level of these expenditures must be more qualitative.

International comparisons are one place to start. Canada's university R&D performance equalled 0.32 percent of GDP in 1987. This is considerably below the levels of some countries. For instance, Japan at 0.57 percent and Sweden at 0.69 percent have much higher levels than Canada (see Table 1). On the other hand, the United States at 0.39 percent in 1986 is not much more university R&D intensive than Canada.

Currently Canada's university R&D comprises about 24.6 percent of all R&D, a performance which is a little above average for OECD countries.[8] To maintain university R&D at 20 percent of total R&D while meeting the 2.5 target, university R&D would have to rise to 0.5 percent of GDP by 1997. This is the target in Figure 2.

The rationale for funding university R&D, unlike that for industrial R&D, is not entirely based on "bottom line" considerations. There are long-term social benefits from university R&D that escape the economic calculus. As well, there are more immediate effects of university research on the ability to, for instance, take care of the environment and prevent disease. There is also considerable national pride involved in the contributions of our basic scientists. This latter point was well highlighted by the occasion of the recent award of a Nobel prize to the University of Toronto scientist, John Polanyi.

There are also more tangible economic benefits from university research. University research provides the basic knowledge for the applied research that firms turn into practical products and processes. In fact, in the very long run, university R&D is the primary source of technological development.

Some observers may argue that Canada can free ride on the basic research undertaken in other countries. However, university research provides the most important conduit for the research of other countries to flow into Canada and eventually to firms. If Canada does not keep up in this respect, it risks being excluded from much of the scientific advancement that originates elsewhere.

Substantial increases in university R&D activity are also a prerequisite for developing the highly-qualified personnel necessary for increased industrial R&D. The Natural Sciences and Engineering Research Council has warned that unless action is taken Canada's economic renewal "will be greatly impeded by critical shortages of skilled researchers", and that "Those same deficiencies will prevent the aspired for doubling of Canada's R&D effort to 2.5 percent of GNP...".[9]

Basic research is necessary to attract and satisfy many of the most highly-qualified scientists. If good research opportunities are not provided, Canada cannot expect to keep many of those highly-qualified scientists.

Another more direct effect of university research on industry takes place in the form of collaborative industry/university R&D. This type of R&D is becoming progressively more important as the sophistication of technology and the technical requirements of firms increase. Both federal and provincial policy have been moving in the direction of an increased role for this type of cooperation. It is this new emphasis that gives the best economic rationale for increasing support to university R&D. The alternative is to cannibalize the more basic pursuits of university R&D.

Targets for university research expenditure of 0.4 percent of GDP by 1992 and 0.5 percent by 1997 are shown in Figure 2. These targets can be obtained with a steady 7.6 percent annual increase in real university R&D expenditures. If the increment (the growth in excess of the GDP growth rate) was devoted primarily to cooperative industry/university research, it would also make the higher industrial R&D expenditures more effective.

Much of the funding for increased university R&D would have to come from government, but there is scope for cost recovery from industry in the case of university R&D that is directly relevant to industry. Additionally, it has been suggested that greater philanthropic support for R&D could be encouraged as is the case in the United States. It would be unrealistic, however, to suppose that more than half of this additional funding could come from the private sector.

Figure 5 shows the incremental government and industry contributions to university R&D expenditures required to meet the target. The incremental funding for the first five years is about $1.3 billion. Government and industry would each be expected to contribute half of that total or about $660 million.

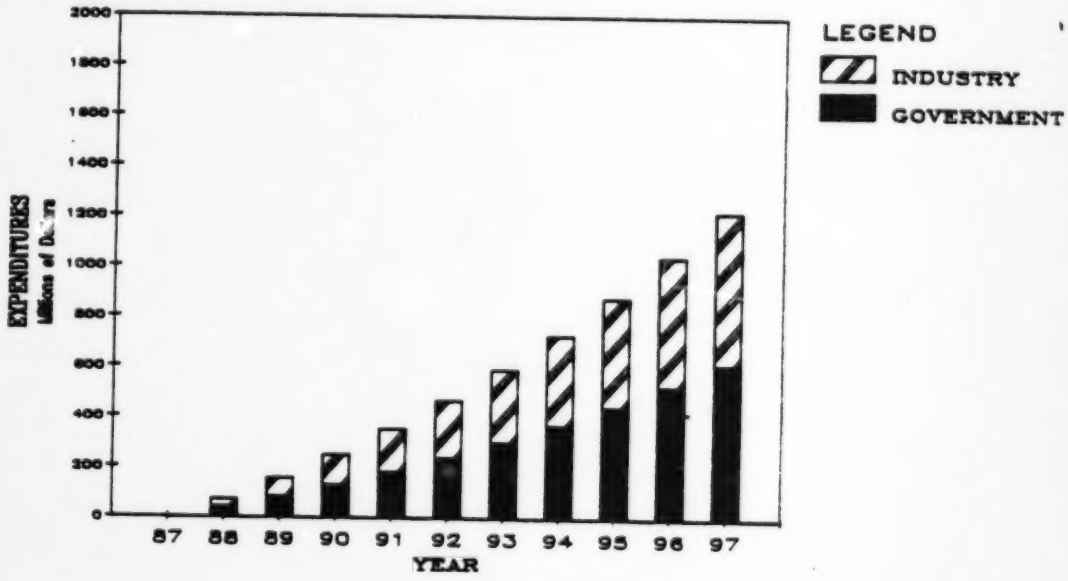
As well as the incremental funds, all present sources of financing would have to rise in proportion to GDP which is expected to grow at 3 percent per year in real terms. Most of this base funding derives ultimately from government. Some of the non-government sources of funding, such as tuition, might not keep pace with GDP growth. New measures to encourage greater philanthropic financing could be used to ensure that non-government sources of funds are at least maintained as a percentage of GDP.

In addition to university R&D, there is also a small, related sector of private non-profit R&D. This sector currently accounts for about 1.4 percent of total R&D. The target in Figure 2 has this category growing to 2 percent of the total by 1997 with two thirds of the incremental expenditures funded by private sources.

FIGURE 5

INCREMENTAL UNIVERSITY R&D
BY FUNDING SECTOR
Constant 1986 Dollars

Figure 5



Government R&D

The final major performing sector for R&D is government itself. Canada currently spends about 0.30 percent of its GDP on intramural government R&D. This is comparable to most other advanced countries. As a percentage of total R&D, however, Canada's government R&D ranks above that of most other advanced countries at 22.5 percent. If government R&D was maintained at its current percentage of GDP, it would fall to about 12 percent of total Canadian R&D by the time the 2.5 target is achieved in 1997. This share would be one of the lower ratios of government R&D performance in the OECD.

Government R&D is generally of two types: R&D to support public objectives directly, such as health or environmental R&D, and R&D carried out to support or develop industry directly. The first type of research is clearly in the realm of what government should do. Decisions regarding this type of R&D have to be made primarily on the basis of specific public objectives and are less amenable to macro analysis than other forms of R&D.

There is no strong case for increasing the overall level of government performed R&D. Therefore, no incremental government R&D performance is proposed. However, some of the incremental funds targeted for industry in the less industrialized provinces might need to be applied with more direct government and university involvement in recognition of the special needs of these regions. This is discussed in detail in the next section.

VI GOVERNMENTS' ROLE IN SUPPORT OF THE TARGET

Other countries that have adopted targets have largely been unitary states. In the Canadian federation, achieving a R&D target must include all the major R&D spenders in the economy as partners, including industry, universities, and governments. The starting place in building a consensus on a R&D target is the two senior levels of government because the viability of a national R&D target is affected by the quality of intergovernmental relations.

The federal government's previous adoption of a R&D target in 1978 was done in isolation from the provinces, universities, and the private sector. Despite this weakness, major increases in Canadian R&D spending were realized. Greater success can be expected with a truly national effort that includes the provinces.

Nothing in Canada's constitutional division of powers limits either level of government from taking maximum advantage of the economic development opportunities offered by R&D policy. Therefore, the pursuit of a rational R&D policy by the federal or provincial governments is not a matter of jurisdiction, but of political will.

Achieving the interim target by the end of 1992 will require incremental government R&D expenditures of about $2.8 billion (1986 dollars). Proposals for dividing the responsibility between the federal government and the provincial governments are outlined below.

An economic perspective on federalism dictates that provinces should be responsible for the provision of public goods which are of exclusive or primary concern to their citizens and the federal government should provide those public goods which have broader implications.

The pure public goods nature of basic research means that the federal government should be primarily responsible for its direct funding and this has historically been the case. Industrial R&D is not a pure public good like basic research but a large part of the benefits of the research do not accrue to the firm performing it. The federal government has traditionally taken the lead role in encouraging industrial R&D because the spillover benefits accrue across Canada.

It is proposed that the federal government fund two thirds of the incremental government expenditures necessary to achieve the interim target and the provinces fund the remaining one third.

Table 6 details the the federal and provincial expenditure implications of adoption of the 1.8 percent interim target.

TABLE 6

Incremental Government Expenditure Implications of Adopting the R&D Target

(millions of 1986 dollars)

	Federal Government	Provincial Governments	Total
1988	104	52	156
1989	222	111	333
1990	358	179	537
1991	513	256	769
1992	688	344	1,032
Total	1,885	942	2,827

The federal government would need to contribute $1.89 billion or about two thirds of the incremental costs of the interim target over five years.

The provinces would have to contribute about $940 million, or one third of the total government contribution. One third is considerably in excess of the historical provincial share. This higher level of provincial responsibility is consistent with the increasing commitment of provincial governments to R&D spending.

The R&D Target and Regional Development

R&D is an important element of regional economic development. Increased R&D will increase the competitiveness of Canadian firms in all parts of Canada. As well, diversification in resource dependent regions will require new product innovations that involve R&D.

Canada's R&D expenditures are not evenly spread across the country. The adoption of the R&D target can be used as a framework for ensuring a more even regional distribution of national R&D expenditures. It is easier to address the issue of the regional allocation of spending when the total level of expenditure is growing.

If provinces each agreed to spend in proportion to the total incremental expenditures of the federal government in that province, each province would see its incremental R&D dollars being multiplied by three through the expenditures of the federal government. When the private sector's share is taken into account, there could be as much as eight dollars of total incremental spending for each dollar spent by a province.

Ontario's proposed target aims at increasing industrial R&D performance as its first priority. However, it could be more difficult in the smaller provinces, and the less industrialized parts of all provinces, for industry to provide its share of the funding. The increased R&D spending will have to be less dependent on industry leadership in these regions which presently have few firms performing R&D.

Less than a two-to-one ratio of industry to government expenditures will likely have to be accepted in the less industrialized regions. Increased R&D investment in these regions will have to come about at least partly through provision of public research infrastructure such as new national and regional laboratories and Centres of Excellence.

In order to ensure that the increased R&D spending resulting from the adoption of a national R&D target is more evenly spread across Canada, provincial R&D targets could be established. Provincial targets would aggregate to the national 2.5 percent target. The provincial targets would be set to ensure a fair regional allocation of the incremental R&D expenditures.

To further improve the regional equity of the target strategy, the federal government could make special provisions in the federal-provincial funding shares for the the less advantaged provinces.

Increased funding of R&D through ERDA subagreements could help ensure that smaller provinces have the financing to pursue their research priorities. As well, the funding of the Western Diversification Initiative and the Atlantic Opportunities Agency aimed at promoting R&D could be augmented.

The consideration of regional development policy instruments necessary to support increased R&D investment could be referred by the CSTM to its existing Working Group on Science and Technology and Regional Economic Development.

The Council of Science and Technology Ministers

Adoption of a 2.5 percent target by Canadian governments will require a new commitment to intergovernmental coordination. A mechanism will be needed to ensure that the expenditure track to the interim target is being met and to ensure that the new policies and programs introduced in support of the target by both levels of government are complementary. Fortunately, much of the intergovernmental machinery is already in place.

The federal/provincial/territorial Council of Science and Technology Ministers (CSTM) could be the forum for discussion of the appropriate division of government funding responsibilities. It could also function as the executive body overseeing the planning, implementation, and monitoring of the government expenditures necessary to achieve the target. The CSTM could consider whether provincial R&D targets are appropriate complements to a national target.

The CSTM now serves as a forum for information exchange between governments on existing and new R&D policies and programs to help reduce policy overlap and to let governments benefit from the program experience of each other. This role would be enhanced if a national target were established.

The CSTM could establish an ongoing, collaborative process involving the private sector to discuss the usefulness of sector-by-sector industrial R&D targets, to develop a consensus on the measures necessary to increase Canada's international competitiveness, and to promote regional economic development. The private sector must be a partner in planning and implementing the target. Given the significant increases in industrial R&D necessary to achieve the target, private sector consultation on the planning of the target is key.

VII POLICY DESIGN

How governments spend on R&D is as important as how much they spend. Policy and program instruments need to be efficient, equitable and responsive to the needs of all sectors and regions of the economy.

This section discusses broad policy areas such as tax, trade, and foreign investment policy as well as specific policy instruments, including direct subsidies, government contracts, and institutions. They are important in maintaining and increasing Canada's R&D.

Tax Policy

The federal government's R&D tax incentives provide a base level of support for industrial R&D. International comparisons have found that Canada's R&D tax incentives are among the most generous in advanced economies. Evaluations of the effects of the R&D tax incentives on industrial R&D spending have generally found them to be an effective method of promoting increased R&D spending in Canada. The government of Quebec has recently expanded its use of tax incentives in support of R&D.

However, the federal government, in its recent White Paper on tax reform, has revealed plans to reduce the value of the present R&D tax incentives by placing a cap on the R&D tax credit. This measure would penalize the firms that are the most R&D intensive.

Five industry associations representing 700 high technology firms oppose this proposed change because it would discourage industrial R&D spending. The industry associations estimate that the restrictions placed on the tax credit would reduce its value by 40 percent.[1] As well, the Parliamentary Standing Committee on Finance and Economic Affairs has recommended that R&D claims should not be limited to one half of federal taxes payable as set out in the White Paper. These changes to the R&D tax incentives, proposed in the White Paper, are not consistent with the need to aggressively augment Canadian industrial R&D spending and increase Canadian productivity and competitiveness.

Trade Policy

Trade liberalization will make increased R&D all the more important in maintaining international competitiveness. Where there is improved access to

international markets, the incentives for R&D will also increase. This is particularly true of multilateral trade liberalization.

Canada must be careful not to give up the industrial policy flexibility that is necessary for technological development in all regions of Canada. An area of concern will be whether or not industrial technology programs are viewed as non-tariff barriers to trade and as such subject to countervail. The international criteria for deciding what is and what is not a non-tariff barrier to trade are still evolving.

If technology promotion policies are deemed to be trade barriers then Canada's efforts to catch up will be impeded. When well-designed technology promotion programs improve the overall efficiency of industry, the promotion of R&D positively effects the level of trade. Unlike subsidies that act as trade barriers, support for R&D is not a zero-sum game. It improves a country's ability to absorb imports as well as its ability to export.

Canada would, therefore, be at a disadvantage if technology promotion policies were restricted. The U.S. provides far more direct support to industrial R&D than Canada, but because most of this money is spent in defence industries, these subsidies are deemed untouchable for national security reasons. The security label put on these subsidies does not stop them from giving an advantage to technology-intensive U.S. firms.

Foreign Investment Policy

Although the high level of foreign control of Canadian manufacturing industries depresses Canadian industrial R&D spending, government policies directly aimed at increasing the rate of adoption of world product mandates by foreign-controlled subsidiaries in Canada can increase Canadian R&D investment.

For instance, government procurement policy has been demonstrated to be an effective instrument for encouraging the adoption of world product mandates.

At the same time, reductions in trade barriers will discourage branch plant operations in favour of rationalized operations or independent Canadian firms which are more conducive to R&D. The problem of low R&D intensity among foreign-controlled firms is amenable to public policy. Between 1974 and 1984, foreign control of Canadian industry assets fell from 34 percent to 24 percent, while many remaining foreign-controlled firms adopted world product mandates[2].

However, weakening the screening process for foreign investment, as the federal government has proposed, would inhibit Canada's ability to deal with this problem. It is vital that Canada maintain its policy flexibility in this respect.

Government Programs

The failure of government industrial development programs is often a result of the program design not being derived from a coherent rationale for government support. Good technology policies and programs can be identified as those that promote activity which has widespread benefits beyond the performing firm. Policy prescriptions which fail to pay attention to this distinction between private and public responsibilities should be avoided.

The approach proposed in this paper suggests that government support for programs should be consistent with a well functioning market economy. This rationale does not involve presumptions about the correctness of the investment decisions of firms. Such decisions should be left in the hands of the private sector unless there is a systematic divergence between private and public benefits. Such a divergence exists for R&D because the benefits of R&D flow far beyond the firm performing it.

Each type of incentive has advantages and disadvantages. The instruments found to be most effective in increasing industrial R&D are primarily tax and grant programs. There are many varieties of tax and grant incentives and some are much better than others. The now defunct SRTC and IRDP programs were examples of tax and grant expenditure programs that were not efficient or effective. On the other hand, the current system of R&D tax credits and the NRC's Industrial Research Assistance Program (IRAP) have been effective in increasing R&D spending and improving the competitive position of Canadian industry.

Government procurement of R&D can also be used for increasing the research performance of industry. R&D required for public purposes can be undertaken within government or contracted-out to private sector researchers. Increased use of contracting-out, when it makes good economic sense, is another way to increase the proportion of R&D performed by industry. However, contracting-out can only reallocate R&D expenditures; it has been found to lack the leverage effects on private R&D funding that grants and tax credits exhibit[3].

Government R&D should be confined to that necessary for meeting public objectives. Although not targeted for increase, government laboratories will remain an important element of Canada's research infrastructure. Government R&D infrastructure is vital to regional development, and cannot be easily replaced by private R&D in the less industrialized regions of the country.

Federal and provincial governments have a large number of instruments for supporting R&D. The best strategy for increasing R&D is to expand the existing successful programs as much as possible, while introducing new programs only where there is a major need that cannot be adequately filled by new funding of existing programs. Canada needs increased R&D expenditures more than it needs an increased proliferation of R&D programs.

CONCLUSION

The adoption of a 2.5 percent national R&D target is a demanding yet prudent strategy for increasing Canadian R&D spending. Increased industrial R&D expenditure will result in increased Canadian productivity and competitiveness. The rate of growth of Canadian incomes ultimately depends on the rate of growth of national productivity - R&D is a good investment.

The adoption of a national R&D target, within the context of a cooperative federal/provincial planning framework, displays tangible commitment by governments to the goal of producing a more competitive Canada. It represents commitment to support long-term economic growth by assisting companies to develop and use technology to improve Canadian competitiveness.

A number of recent events have increased the likelihood that a R&D target for increasing Canadian R&D investment can be successful:

- the founding of the Council of Science and Technology Ministers provides the intergovernmental machinery for a concerted national strategy of increasing Canadian R&D investment;

- Canadian industry is increasingly aware that R&D investment is an urgent prerequisite for increasing its international competitiveness; for example, the Canadian Manufacturers' Association recognizes that Canadian companies must commit more R&D investment if they are to survive increasing international competition;

- provincial governments are increasing their R&D spending and developing innovative new policy approaches to bolster Canada's R&D investment;

- university and industry researchers are increasingly collaborating to perform industrially relevant R&D in universities.

In this context, Ontario recommends the following policy proposals as opportune and important to the future economic and regional development of Canada:

- Establish a national R&D target that will demonstrate commitment to increased Canadian R&D investment and provide a framework for cooperative action by governments, industry and universities;

- Set the national R&D target at 2.5 percent of GDP to be achieved by 1997, accompanied by an interim target of 1.8 percent to be achieved by 1992;

- Mandate the Council of Science and Technology Ministers to be responsible for the planning, implementation, and monitoring of the target to:

  - ensure that the incremental R&D expenditures necessary to achieve the target are fairly distributed among the provinces. The Council should consider policies such as provincial targets and a lower provincial expenditure burden for the less advantaged provinces;

  - consult with industry on the policy instruments necessary to increase industrial R&D spending and on the possibility of adopting industry-by-industry targets.

- Review and evaluate the design of government incentives to increase industrial R&D investment in order to ensure that taxpayers' money is wisely invested.

NOTES

I R&D AND CANADA'S ECONOMIC FUTURE

1. For instance, a fairly broad review is contained in a study commissioned by MOSST: Donald G. Mcfetridge and Patrick Grady, The Economics of Research and Development: A Review of the Literature and Some Proposals for Future Research (Ottawa: Grady & Associates Economics, 1985), pp. 46-74. (Mimeo)

2. Jeffrey Bernstein, Interindustry R&D Spillovers, Private and Social Rates of Return to R&D Capital (Ottawa: Science Council of Canada, August, 1987), p. 5. This Study found private rates of return between 26 percent and 47 percent depending on the industry. Calculations show that the weighted average was 38 percent - where the weights are the industry's share of the total R&D. The social rates of return were found to be between 29 percent and 146 percent, with a weighted average of 58 percent.

3. Jeffrey Bernstein, R&D Spillovers, Rates of Return and Costs of Production in Canadian Industry (Ottawa: Science Council of Canada, 1985), pp. 43-44. Bernstein found evidence that the spillovers from intra-industry R&D capital are complementary to internal R&D capital. Also, technology payments have been found to complement internal R&D, Frank Longo, Industrial R&D and Productivity in Canada (Ottawa: Science Council of Canada, May, 1984), P. 35.

4. "Science and Technology, Dynamic Source of Development", KOREA Business World (May, 1987), pp. 25-27.

5. Total Spending on Research and Development In Canada, 88-001 (Ottawa: Statistics Canada, May, 1987), p. 2.

6. Ibid., p. 2

II THE REASONS FOR CANADA'S LOW R&D PERFORMANCE

1. Industrial Research and Development Statistics 1984, 88-202 (Ottawa: Statistics Canada, July, 1986), p. 92.

2. Selected Science and Technology Indicators: Recent Results 1981-1987 (Paris: OECD, 1987).

III GOVERNMENT R&D POLICY IN CANADA

1. "Progressive Conservative Campaign Handbook" (1984), cited by David Berger, House of Commons, Official Report of Debates, October 22, 1986 (Ottawa: Queen's Printer, 1986), p. 618.

2. The Right Honourable Brian Mulroney, "Notes for an Address on Research and Development," University of Waterloo, March 4, 1987.

IV PERFORMANCE TARGETS FOR R&D

1. Selected Science and Technology Indicators: Recent Results 1981-1987 (Paris: OECD, 1987).

2. Recommendation of the Council for Science and Technology: Comprehensive Fundamental Policy for Promotion of Science and Technology to Focus Current Changing Situations from the Long-Term View (Japan: The Council for Science and Technology, 1984), p. 20.

3. "Science and Technology, Dynamic Source of Development", KOREA Business World (May, 1987), p. 27.

4. Ibid., p. 26.

5. Selected Science and Technology Indicators: Recent Results 1981-1987 (Paris: OECD, 1987).

6. John Roberts, Speech to the Toronto Board of Trade, January, 1981.

7. Total Spending on Research and Development In Canada, 88-001 (Ottawa: Statistics Canada, January, 1987).

The figures given in the discussion of the previous Canadian target are expressed as a percentage of GNP rather than GDP, and do not include Social Sciences. This was the old Statistics Canada convention, which was used at the time of that target. All the other numbers given in this paper follow the OECD convention, since adopted by Statistics Canada, which includes Social Sciences and uses GDP as the denominator.

V ACHIEVING THE TARGET

1. Technological Innovation: An industrial Imperative (Halifax, The Council of Maritime Premiers Committee on Research and Development, 1981), p. 29.

2. Total Spending on Research and Development in Canada, 88-001 (Ottawa: Statistics Canada, May, 1987).

3. Ibid., p. 2.

4. Bernstein, (1987), Op. cit. p. 5 (see Note 2 R&D and Canada's Economic Future).

5. Jeffrey Bernstein, "The Effect of Tax Expenditures on the Canadian Industrial R&D Expenditures," Canadian Public Policy, v. 12, no. 3 (September, 1986), p. 444.

6. Longo, Op. cit. p. 34.

7. The long-term growth of industrial R&D is shown in Table 5. In the ten years from 1977 to 1986, industrial R&D grew by 124 percent in real terms. Some of this growth was due to increased government support. However, even with generous assumptions about the effect of government support, it can be shown that there is growth in private R&D expenditures that is independent of the effect of government support.

   Direct government support in 1986 was $412M. The taxes foregone because of the tax credits are estimated to be equal to about 9.5 percent of total industrial R&D. (see Appendix C) In 1986 total industrial R&D was $3,457M, so the tax credits were worth about $328M in 1986 (this is a relatively generous estimate). Adding the tax credits to the direct support gives $740M total government support in 1986. If we assume that an additional $740M of private funding was leveraged by the government support, the private funding would have been $1,977M in 1986 without any government leverage (3,457 - 2x740 = 1,977).

   Industrial R&D was $857M in 1977 and direct government support was $120M (there were no R&D tax credits until March 1977). Making the same leverage assumption as for 1986, the private funding would have been $617M in 1977 without government support (857 - 2x120 = 617).

This $617M translates to $1,110M in 1986 dollars. Thus, privately motivated funding increased from $1,110M to $1,977M in 1986 dollars, between 1977 and 1986. This is a real increase of 78%, which is 2.7 times the 29% growth in real GDP that occurred during that period.

8. Special Statistics Canada Tabulations.

9. Completing the Bridge to the 90's: NSERC's Second Five Year Plan (Ottawa: Natural Sciences and Engineering Research Council, 1985), p. vii.

VII POLICY DESIGN

1. Submission on the White Paper on Tax Reform by ITAC and other Industry Associations, 1987, p. ii.

2. Corporations and Labour Unions Returns Act - Part I, 67-210 (Ottawa: Statistics Canada, April, 1987) p. 8, and Multinationals and Industrial Strategy: The Role of World Product Mandates (Ottawa: Science Council of Canada, 1980).

3. Mcfetridge and Grady Op. cit. p. 5 and p. 8.

APPENDIX A

R&D Intensity and Firm Size

The chart below shows the relationship between size of firm, as measured by employment, and R&D intensity. This data is taken directly from a Statistics Canada publication and is based on the complete inventory of R&D performing firms, not a sample.*

R&D As a Percentage of Sales

Employment	1977	1981	1984
1 - 49	2.5	4.7	14.4
50 - 100	3.7	1.1	6.5
100 - 199	2.4	3.3	3.7
200 - 499	1.3	1.6	2.5
500 - 999	1.8	1.4	1.4
1000 - 1999	0.6	0.8	1.3
2000 - 4999	0.7	0.8	1.0
>4999	0.7	0.9	0.9

More sophisticated analyses of the relationship between size and R&D intensity have also been made. The econometric evidence has shown that the elasticity of R&D with respect to output is slightly less than one,** which indicates that there is virtually no effect of size on R&D intensity.

* Industrial Research and Development Statistics, 1984 Report 88-202 (Ottawa: Statistics Canada, July, 1986), p. 92.

** Jeffrey Bernstein, "Issues in the Determinants and Returns to R&D Capital", p. 21, MOSST (Mimeo), Ottawa, 1986.

APPENDIX B

Relationship between R&D Intensity and Industrial Structure

The extent that Canada's low R&D intensity is affected by the resource-orientation of Canadian industry is an issue that has been debated extensively.

The issue can be stated as a question: What would the R&D intensity of other countries be if they had the same industry structure as Canada? This question can be answered empirically. Below is a comparison of Canada and the U.S.

Total R&D intensity (R) can be expressed as the weighted average of R&D intensities in different industries:

$$R = \Sigma W_i R_i;$$

where W_i = the share of Total output for the ith industry ($output_i$ / Total output), and R_i = R&D intensity of industry (i) ($R\&D_i$ / $output_i$).

For Canada, $R^c = \Sigma W^c{}_i R^c{}_i$.

For the U.S., $R^a = \Sigma W^a{}_i R^a{}_i$.

U.S R&D intensity with Canadian industry weights would then be:

$$R^* = \Sigma W^c{}_i R^a{}_i.$$

The table below shows U.S. R&D intensities by manufacturing industry (using GDP as the measure of output). Column 2 shows the percentage of industry GDP accounted for by each industry. Column 3 shows the same numbers for Canada.

The Canadian distribution within manufacturing is calculated with 1971 $ values. The current dollar values within manufacturing were unavailable. All numbers are for 1980, which is the latest year for which full U.S. industry breakdowns of R&D were available.

At the bottom of the chart (next page) the weighted average is shown for U.S. industry in total. This R&D intensity is then recalculated with Canadian weights. The U.S. intensity falls from 1.91 percent to 1.57 percent if the Canadian weights are used. This compares to 0.70 percent for Canada. Thus, industry structure accounts for only about 28 percent of the difference. [(1.91 - 1.57)/(1.91 - 0.70) = .28]

In 1986, U.S. industrial R&D was 2.07 percent of total GDP (see Table 1.2), while the figure for Canada was 0.68 percent. The difference between these two figures is 1.39 percent, and 28 percent of that difference is about 0.39 percent of GDP. Thus the best estimate is that U.S. industrial R&D would have been about 1.68 percent of GDP instead of 2.07 percent in 1986 if the U.S. had Canada's industry structure. This would lower U.S. total R&D from 2.89 percent of GDP to 2.5 percent for 1986.

Industry	U.S. R&D/GDP	U.S Weights	Canadian Weights
Food & Kindred	1.03	0.0258	0.0332
Textiles etc.	0.32	0.0153	0.0196
Wood Products	0.55	0.0116	0.0168
Paper Products	0.90	0.0237	0.0348
Chemicals & Petroleum	8.18	0.0357	0.0284
Non-Metallic Minerals	2.15	0.0081	0.0090
Basic Metals	1.63	0.0191	0.0197
Machinery & Metal Fab.	12.98	0.1091	0.0848
Other Mftrg.	4.12	0.0038	0.0073
Total Mftrg.	7.32	0.2521	0.2536
Non-Mftrg.	0.10	0.7479	0.7464
All Industries (R^a)	1.91	1.0000	
All Industries Canadian Weights (R^*)	1.57		1.0000

Sources: National Accounts, OECD, 1972-1984.
NSF, Research and Development in Industry, 1984.

APPENDIX C

Tax Expenditures on Incremental R&D

Calculated below is the value of tax expenditures that would be forthcoming automatically, in the pre-tax reform regime, if the targeted incremental industry R&D occurred.

The current tax credits are worth about 12 cents per dollar of R&D for large firms and about 28 cents per dollar of R&D for the small firms. This is arrived at because the tax credits for large and small firms, of 20 percent and 35 percent are taxable at rates of 40 percent and 20 percent respectively. Because small firms account for about 10 percent of industrial R&D, the weighted average value of the credits is about 13.6 cents for a dollar of eligible industrial R&D.

The total incremental private R&D funding is about $4.9 billion. On the basis of past estimates it is assumed that 70 percent of this is eligible for the tax credits. R&D can be ineligible for the tax credits because the performing firm is not in a profitable position, because the R&D is foreign or government funded, or because the expenditure does not meet the tax definition of R&D which is slightly narrower than the Frascatti definition used for statistical purposes.

The credits thus have a value of about 9.5 percent of total R&D (13.6 percent times 0.7). Because the value of the incremental tax credits are to be counted as part of government share of R&D funding, the direct private funding of R&D will equal $4.9 billion plus the value of the tax credits. The equation used to calculate the value of the credits also takes this into account:

$$\text{Tax credits} = (0.136)\,[(0.7)\$4.9\text{B} + \text{Tax Credits}]$$

$$= 1.157(0.136)(0.7)(\$4.9\text{B})$$

$$= \$0.54\text{B or } \$540 \text{ million}$$

Tax Incentives in Canada versus the U.S.

The American tax credit is 20 percent for current incremental R&D. It is non-taxable. Estimates are that between 15 percent and 30 percent of American R&D is incremental and eligible. This means that the value of the tax credit is between 3 and 6 cents per dollar of R&D. This compares to the 9.5 cents per dollar of R&D estimate for the Canadian tax credits. Thus the Canadian credits are worth between 3.5 cents and 6.5 cents more than the American credit per dollar of R&D. Thus the tax credits counter between 16 percent and 30 percent of the 22 cents per dollar difference in direct government support.

APPENDIX D

Background Tables

Table D-1 shows the target levels of R&D in comparison to a "business as usual" scenario in which R&D expenditures merely keep pace with GDP. The difference is the incremental R&D.

Table D-1

Total R&D Target
(millions of constant 1986 dollars)

Year	GDP Path	Incremental	Target
1987	6833	n.a.	n.a.
1988	7038	426	7464
1989	7249	915	8164
1990	7467	1474	8941
1991	7691	2113	9804
1992	7921	2842	10763
1993	8159	3670	11829
1994	8404	4612	13016
1995	8656	5681	14337
1996	8916	6892	15808
1997	9183	8266	17449

Table D-2 shows incremental R&D by funding sector.

Table D-2

Incremental R&D
by Sector of Funding
(millions of constant 1986 dollars)

Year	Industry	Government	PNP	Total
1988	263	156	7	426
1989	566	333	16	915
1990	913	537	24	1474
1991	1308	769	36	2113
1992	1761	1032	49	2842
1993	2277	1331	62	3670
1994	2863	1670	79	4612
1995	3529	2053	99	5681
1996	4286	2486	120	6892
1997	5144	2976	146	8266

The Tables D-3 and D-4 show the government and industry shares on the incremental R&D by sector of performance.

Table D-3

Incremental Government Funding
by Sector of Performance
(millions of constant 1986 dollars)

Year	Industry	University	FNP	Government	Total
1988	113	38	3	2	156
1989	242	81	7	3	333
1990	392	128	12	5	537
1991	565	179	18	7	769
1992	763	236	24	9	1032
1993	989	299	31	12	1331
1994	1248	367	40	15	1670
1995	1544	442	50	17	2053
1996	1881	524	61	20	2486
1997	2265	614	74	23	2976

Table D-4

Incremental Industry Funding
by Sector of Performance
(millions of constant 1986 dollars)

Year	Industry	University	Total
1988	225	38	263
1989	485	81	566
1990	785	128	913
1991	1129	179	1308
1992	1525	236	1761
1993	1978	299	2277
1994	2496	367	2863
1995	3087	442	3529
1996	3762	524	4286
1997	4530	614	5144

Tables D-5 through D-8 show the total targeted R&D performing and funding breakdowns. The government numbers given for 1987 do not include tax expenditures. However, the projected numbers could be partly financed by incremental tax expenditures as mentioned in the body of the paper.

Table D-5

Total R&D
by Sector of Performance
(millions of constant 1986 dollars)

Year	Industry	Government	University	PNP	Total
1987	3513	1542	1684	94	6833
1988	3956	1590	1811	107	7464
1989	4455	1639	1948	122	8164
1990	5016	1690	2096	139	8941
1991	5648	1743	2254	158	9804
1992	6360	1797	2424	181	10763
1993	7162	1853	2608	206	11829
1994	8065	1911	2805	235	13016
1995	9082	1970	3017	268	14337
1996	10227	2031	3245	305	15808
1997	11516	2095	3490	348	17449

Table D-6

Total R&D
by Sector of Funding
(millions of constant 1986 dollars)

Year	Industry	Government	University	PNP	Total
1987	3196	2763	657	216	6833
1988	3556	3002	676	230	7464
1989	3957	3266	697	244	8164
1990	4406	3557	718	261	8941
1991	4907	3879	739	279	9804
1992	5467	4236	761	299	10763
1993	6094	4630	784	321	11829
1994	6795	5068	808	346	13016
1995	7579	5552	832	373	14337
1996	8457	6091	857	404	15808
1997	9439	6688	883	439	17449

The Tables D-7 and D-8 show the government and industry expenditures by sector of funding.

Table D-7

Total Industrial R&D Expenditures
by Sector of Funding
(millions of constant 1986 dollars)

Year	Industry	Government	Total
1987	3096	417	3513
1988	3413	542	3956
1989	3769	685	4455
1990	4168	849	5016
1991	4614	1035	5648
1992	5114	1247	6360
1993	5675	1488	7162
1994	6304	1762	8065
1995	7009	2073	9082
1996	7801	2426	10227
1997	8690	2826	11516

Table D-8

Total University R&D Expenditures
by Sector of Funding
(millions of constant 1986 dollars)

Year	Industry & PNP	University	Government	Total
1987	257	657	770	1684
1988	303	676	832	1811
1989	354	697	898	1948
1990	409	718	969	2096
1991	469	739	1046	2254
1992	534	761	1129	2424
1993	606	784	1218	2608
1994	683	808	1314	2805
1995	768	832	1417	3017
1996	859	857	1529	3245
1997	960	883	1648	3490